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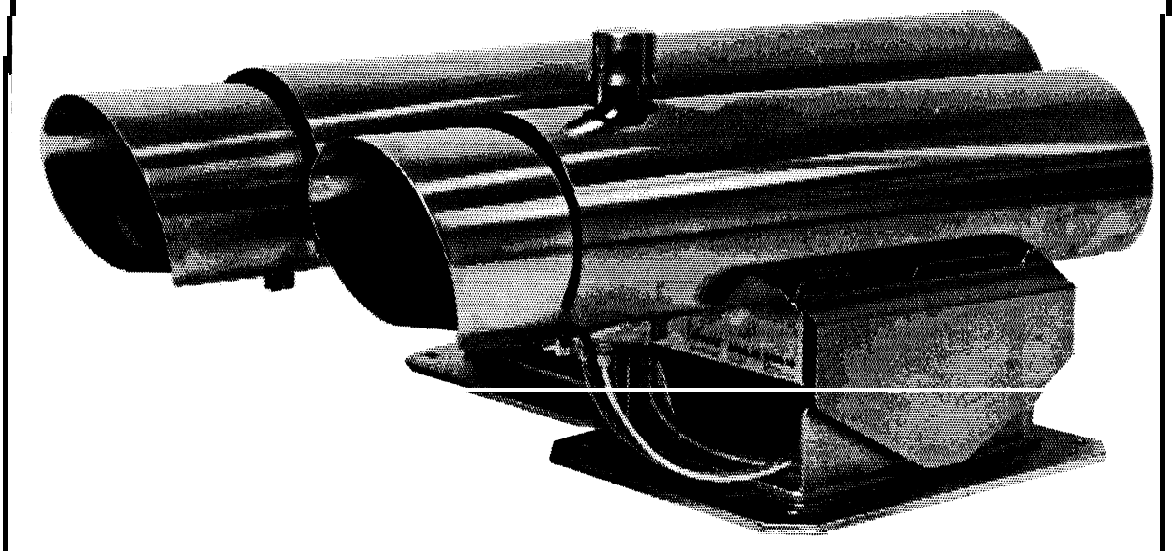

EMITTER / RECEIVER ER 150

USER'S MANUAL

CONTENTS

1. DESCRIPTION OF THE EQUIPMENT

INTRODUCTION

The ER 150 consists of the emitter EM 150, and the receiver RE 150. They are designed for the measurement and analysis of atmospheric gases in outdoor environments. They are used in combination with the AR 500 analysers.

The ER 150 system can transmit and receive light over a pathlength of up to 1000 metres. At pathlengths shorter than 500 metres the Opsis ER 110 pair can also be used. The emitter is equipped with a continuous high-pressure xenon lamp, which is located close to the focal point of a parabolic mirror. The light emitted by the emitter is thus almost parallel. The divergence is about 2 mrad.

The receiver is also equipped with a parabolic mirror. This mirror collects and focuses the received light onto the end of an optic fibre, which is located at the focal point of the mirror.

The fibre is leading the captured light to the opto-analysis unit, which then can be protected from temperature variations, humidity, dust, etc.

The standard lamp is designated Type B. This lamp is useful for the monitoring of most components, except nitric oxide and ammonia. When one, or both, of these species are to be measured the lamp has to be Type A. This type is, however, also generating ozone. The monitoring of ozone levels can therefore not be made without an appropriate ventilation of the telescope. For this purpose the fan VF 020 should be attached to the emitter telescope.

In order to start and run the system, an Opsis PS 150 power supply is required.

1.1 SPECIFICATIONS

	Emitter EM 150	Receiver RE 150
Length, incl. cover	1075 mm	1375 mm
Length, excl. cover	800 mm	1100 mm
Total height	425 mm	320 mm
Diameter of telescope	205 mm	205 mm
Focal length of mirror	640 mm	900 mm
diameter	150 mm	150 mm
Window material	Quartz glass	
diameter	150 mm	
thickness	5 mm	
Operating temperature	-40°C – +50°C	
Degree of protection	IP 54	
Material	Stainless steel ss 2343	
Base plate dimensions	500 x 400 mm^2	
Total weight	approx. 55 kg	approx. 60 kg
Mounting	On stable base	
Lamp		
type	high-pressure xenon Type B (standard), or Type A	
power	150 w	
Beam divergence	2 mrad	
Ignition unit		
casing material	aluminium	
dimensions	174 x 98 x 75 mm^3	

1.2 THE EMITTER AND THE RECEIVER

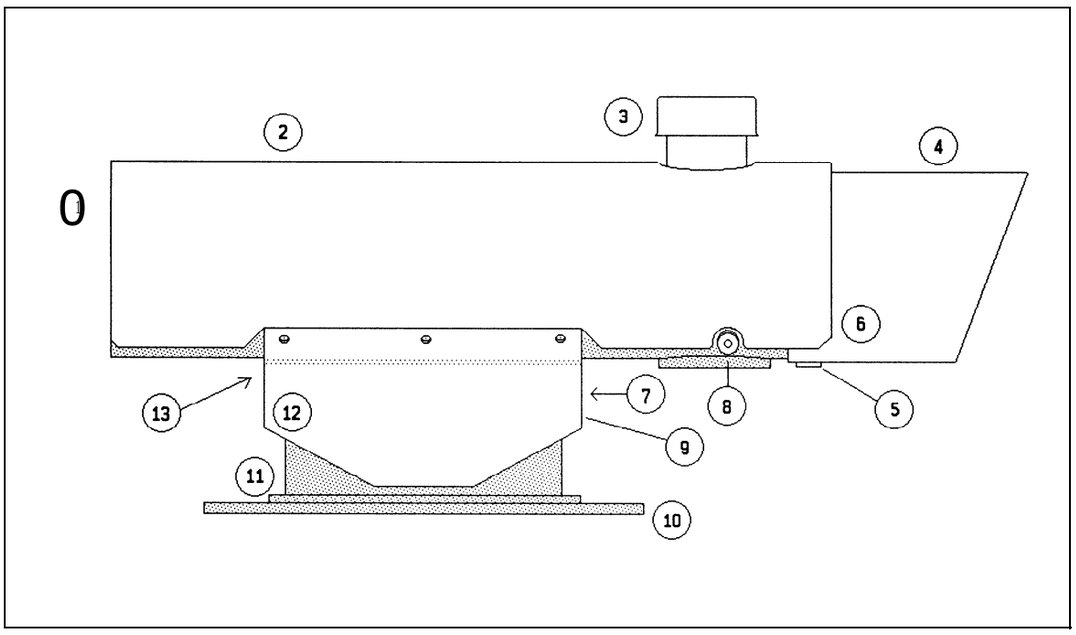

Figure 1.1 The emitter.

1. cover plate for mirror
2. radiation shield
3. ventilation for lamp
4. protective hood
5. fixing screw for protective cover
6. axial adjustment screw (inside the window)
7. lamp ignition unit *
8. access hole for horizontal adjustment screw
9. serial number
10. bottom plate
11. mounting plate
12. cover plates
13. connection for ventilation fan VF 020

*) for details, please refer to the PS 150 manual.

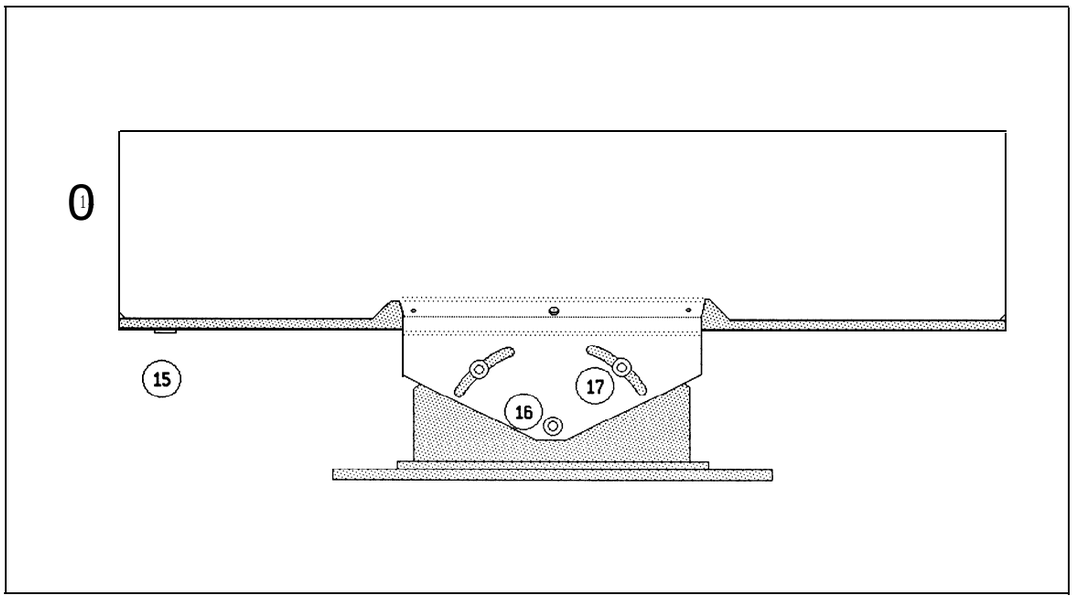

Figure 1.2 **The** receiver. **The** protective hood and the cover plate have been removed.

14. quartz window
15. access for optical fibre, and cable grip nut
16. pivot screw for telescope elevation
17. elevation fixing screws

1.3 THE LAMP HOLDER

The lamp holder is attached to the telescope from below by four screws. The lamp can be replaced through the ventilation hole, and the base plate is thus not necessary to remove. To gain access to the three fine adjustment screws, the protective screws in the telescope, and the window, must first be removed.

On delivery the lamp is adjusted for a monitoring path length of approximately 500 m.

The lamp ignition unit is mounted on the underside of the emitter. This unit is described in detail in the power supply PS 150 manual. Please note that when using the older version of PS 150 the ignition unit is placed in the power supply box. The lamp power cables are then drawn through the lamp holder base plate and attached to it with cable grip nuts.

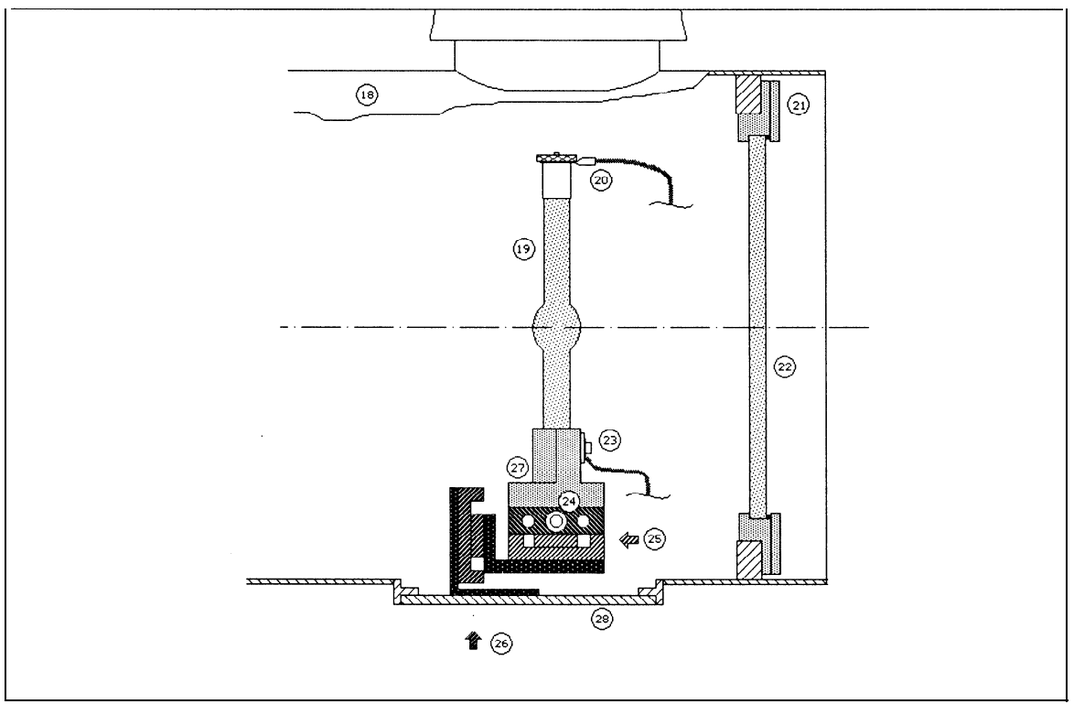

Figure 1.3 Lamp holder, side view.

18. telescope
19. xenon lamp
20. cable grip nut (+)
21. window holder
22. quartz window
23. fixing screw for lamp and earth cable
24. horizontal adjustment screw
25. axial adjustment screw
26. vertical adjustment screw
27. ceramic lamp socket
28. lamp holder base plate

1.4 THE FIBRE HOLDER

The translator mechanism for the fibre holder has the same design as for the lamp holder. The base plate is attached to the telescope at the inside by four screws. It can be placed at several different axial positions, depending on the required focusing.

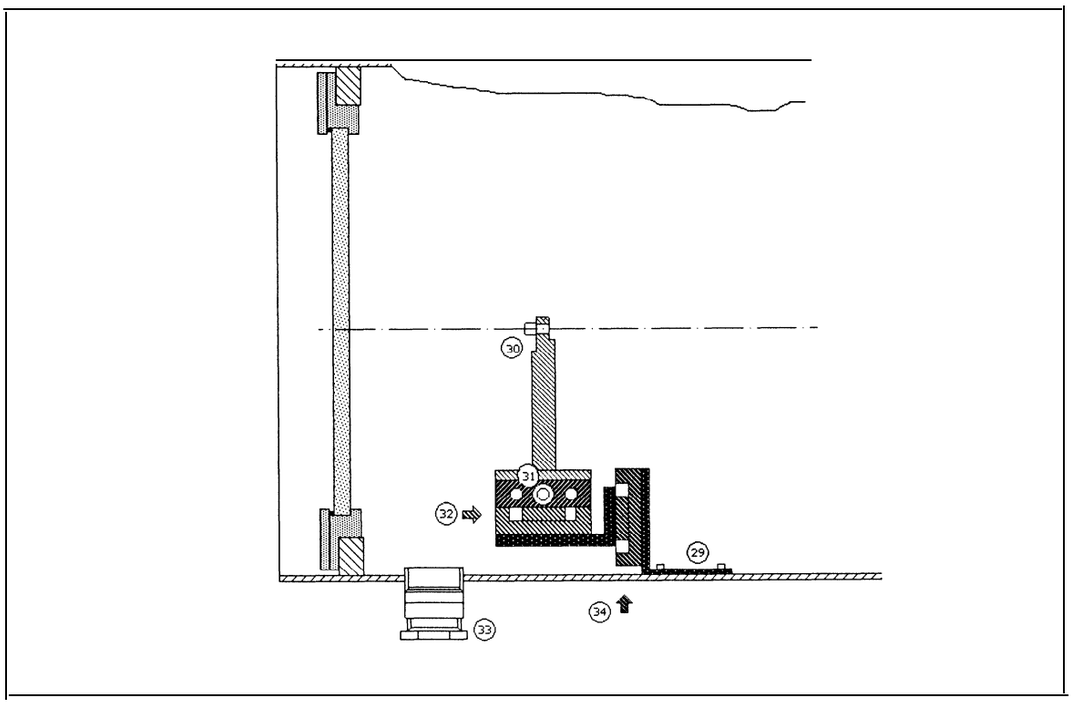

Figure 1.4 The fibre holder and its attachment in the telescope.

29. fixing screws (4) for attachment of fibre holder in the telescope
30. threaded fibre-optic connector
31. horizontal adjustment screw
32. axial adjustment screw
33. access for optical fibre and cable grip nut
34. vertical adjustment screw

1.5 THE LAMP

The xenon lamp used in the ER 150 is a point light source. Light is generated by spark discharge through high-purity xenon gas, at a pressure of about 30 bar. The lamp is powered by a stable DC supply, and requires a short high-voltage initiation pulse of a few tens of kV. The pressure in the lamp is still about 10 bars when it is cold.

The radiation from the lamp consists of ultraviolet, visible and infrared wavelengths. The wavelength distribution is continuous, apart from some wavelengths in the visible region, see figure 1.5 below.

Two different types of lamp are available. The only difference between them lies in the far ultraviolet part of the spectrum. The Type B lamp has a cut-off at wavelengths shorter than 220 nm. The Type A lamp produces radiation down to 185 nm, but generates ozone. The former can be used for the measurement of most compounds except NO and NH_3. The latter is used in the measurement of NO and NH_3 but cannot be used to measure ozone, if not the ventilation fan VF 020 is connected.

The lamps have the following specifications:

Lamp types	Type B, ozone-free
	Type A, ozone generating
Power dissipation	150w
Spark length	2.0 mm
Lamp current	8.0 (±0.5) A DC
Voltage across lamp	approx. 18 V DC

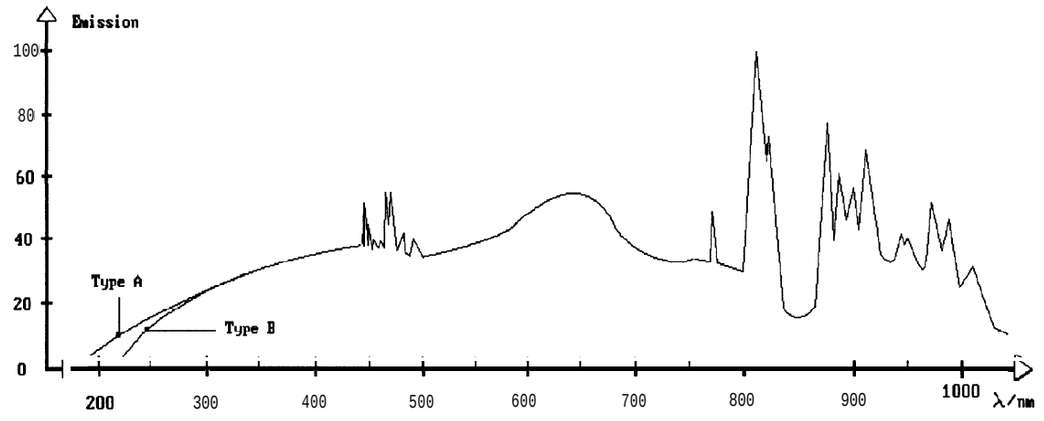

Figure 1.5 Spectral distributions for the two xenon lamp types.

1.6 THE IGNITION UNIT

The ignition unit is generating a very short high-voltage pulse in order to start the xenon lamp. The unit is activated by a DC voltage on 80 V delivered by the Opsis power supply PS 150. As long as the lamp current is zero, i.e. the lamp has not started, a new high-voltage pulse is generated approximately every fifth second.

The ignition unit is mounted directly onto the emitter telescope from which follows that the lamp cables are kept very short.

The cable from the power supply PS 150 is connected to the AMP terminal on the aluminium housing. For more information, please see the Opsis PS 150 user's manual.

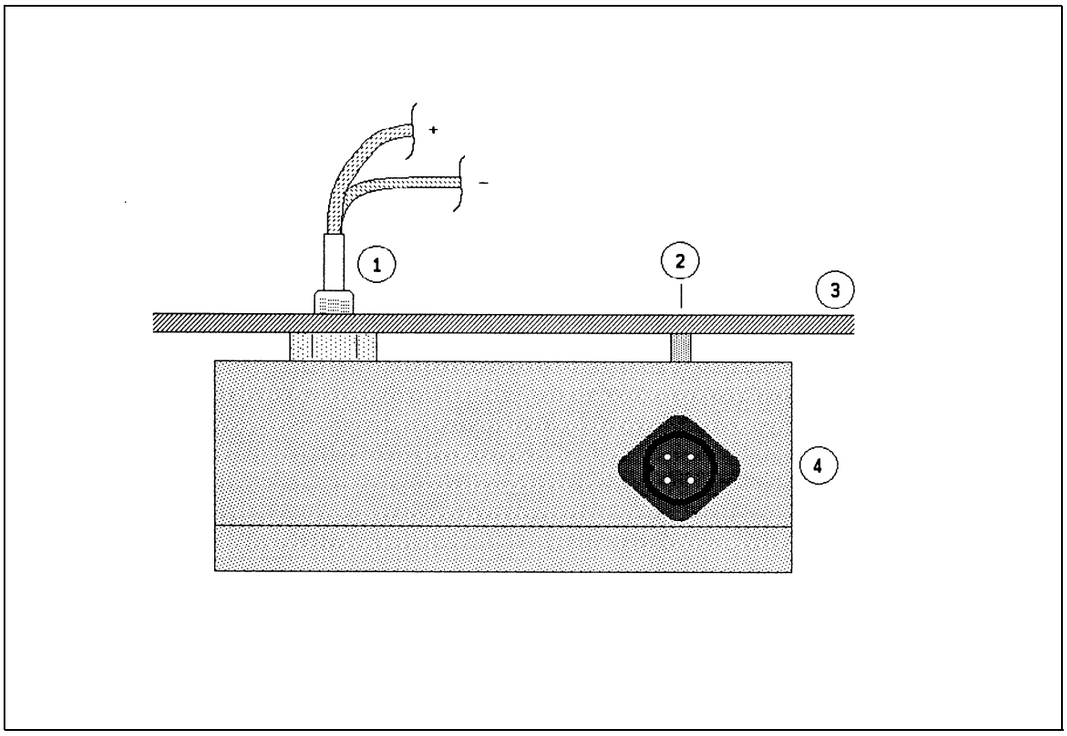

Fig. 1.6 The ignition unit.

1. lamp terminals
2. supporting screw
3. emitter
4. AMP connector

2. BEFOREUSINGTHEERl50

2.1 SAFETY REGULATIONS

- The xenon lamp in the emitter is a continuous discharge lamp which is initiated by a high-voltage pulse. The voltage of this pulse is about 30 000 volts. **Failure to follow the installation instructions and safety regulations may endanger life.**

- **Protective glasses shall be worn at all times when working with the lamp due to the risk of explosion.** The xenon lamp is a high-pressure lamp. This means that the pressure in the lamp at room temperature is about 10 bar, while during operation it rises to about 30 bar. A small scratch on the lamp may cause it to explode, propelling small fragments of glass with great force. It is therefore also recommended that long-sleeved clothing and gloves be worn, thus protecting the skin. Refrain from removing the protective sheath as far as is possible.

- **Never touch the glass with bare fingers.** Fingerprints reduce the transmission of the glass, which increases the temperature of the bulb, and thus the risk of explosion. Dust and fingerprints can be removed by carefully cleaning the lamp with a soft cotton cloth and pure alcohol or acetone.

- **The lamp must be installed with the anode (+) upwards.** It may lean at most 15” from the vertical during operation. Incorrect installation of the lamp will lead to an alteration in its spectrum, resulting in errors in the measurements. There is also a considerable risk that the lamp will not function at all.

- **Ultraviolet radiation is emitted by the lamp.** Never look directly into the lamp without protective glasses. Naked skin should also be protected from UV irradiation.

- **During operation the lamp becomes very hot.** Do not, therefore, touch the lamp until it has cooled down.

- **Used lamps should be handled as carefully as new ones.** Never leave a lamp without a protective sheath. When changing a lamp, the protective sheath should be transferred from the new lamp to the old one.

- **When the lamp ignition unit is integrated inside the power supply PS 150 unit** (older versions only), **make sure that the earth connection between the power supply and the ER 150 emitter is properly connected before switching on power to the lamp.**

2.2 PRECAUTIONARY MEASURES

All service and maintenance inside the instruments may be done only by service personnel authorized by Opsis.

- The emitter and receiver should be stably mounted. They should be securely screwed down to avoid the influence of wind and weather. (Ensure that adequate safety measures have been taken for installation personnel working in areas where there is a risk of falling.)
- Use only the Opsis PS 150 power supply for the xenon lamp.
- Ensure that the power supply is connected to a 230 V AC (+ 6, -10%) or 115 v (±10%) mains supply, and that the supply unit is properly earthed.
- Never work on the power supply while it is connected to the mains.
- Ensure that the cables are correctly connected to the power supply before it is connected to the mains.
- Use only original cables and never make joins in cables.
- The optical fibre is very fragile. It should, therefore, not be subjected to blows or pressure, and should not be bent to a radius of less than about 10 cm. The fibre is also very sensitive to axial torsion. Do not, therefore, allow the fibre to hang freely from a height of greater than about 5 m.
- The polished ends of the fibre are very sensitive to dust and dirt. Ensure that they are protected at all times. If they should need to be cleaned, a soft cotton cloth or lens tissues may be used, with a little alcohol if necessary. Never touch the ends of the fibres with your fingers, and do not use fabrics containing synthetic fibres for cleaning.
- Never couple two fibre-optic cables without first ensuring that the ends are perfectly clean. In a threaded connection between two such cables, the ends of the fibres are no more than a few micrometres away from each other. Dust and dirt which may have found their way onto the connection can easily damage the ends of the fibres.
- Never touch the reflective surface of the two mirrors. The surface coating is very sensitive.

3. INSTALLATION

In choosing the site for the equipment, the following should be borne in mind.

- Choose a suitable measuring path. If possible, contact a meteorologist for help in choosing the optimal location.
- Try to minimize distance between the receiver and the analyser. If possible, the fibre-optic cable should be no longer than 10 metres.
- A mains supply of 230 V **AC** (or 115 V **AC**) must be available for both the emitter and the analyser. A telephone should also be available at the analyser site.
- The analyser must be temperature controlled. Avoid exposing the unit to dust, humidity, vibrations, etc.
- The foundations for the emitter and the receiver must be carefully chosen. Movements and instabilities will cause loss of light. Steel buildings and wooden platforms should be avoided, as they tend to move more than brick buildings when the wind and temperature conditions vary.
- For wall mounting the brackets BR 040 can be used.

For the installation a number of the tools in the Opsis Toolbox TB 001 are required, among them

wrenches

a set of Allen keys

a lux meter LM 010

an optical fibre, 1 to 2 metres long

3.1 INSTALLATION OF THE EMITTER

1. Place a reflecting screen or a retroreflector where the receiver is to be installed. (The numbers given in brackets refer to the numbers in the figures 1.1 to 1.4.)

2. Unscrew the bottom plate [10] from the mounting plate [11] (four screws). Attach the bottom plate on the foundation.

   When the brackets BR 040 for wall mounting are used, proceed as follows: Drill holes for, and attach one bracket to the wall. Mount the bottom plate to this bracket and tighten the bolts. Check where the holes for the other bracket should be, and drill them. Attach the second bracket to the wall and the bottom plate, and tighten the bolts.

3. Put the knob on the mounting plate into the centre hole of the bottom plate, and direct the telescope towards the receiver. Attach the mounting plate with the four screws, without tightening them completely. Loosen the two fixing screws [17] on each side of the telescope, and the pivot screws [16] if necessary, so that the angle of elevation of the telescope can be altered.

4. Direct the telescope towards the location of the receiver. Connect the power cables and the earth connection (if it exists) to the power supply and turn on the lamp.

5. Adjust the telescope roughly so that the light beam hits the screen positioned at the receiver site. Check that the lateral and the vertical adjustment translators ([24] and [26]) are in their middle positions. Tighten all fixing screws.

6. The light beam can now be adjusted vertically and horizontally using the fine adjustment screws on the lamp holder. (To gain access to these screws, the protective screws on the telescope must first be removed.) Turning screw [24] clockwise causes the light beam to move to the left. Turning screw [26] clockwise causes the beam to move upwards. The axial position of the lamp is adjusted for a distance of about 500 metres on delivery. This distance can be reduced by turning screw [25] in a clockwise direction. To gain access to screw [25] the window has to be removed, see figure 3.1.

3.2 INSTALLATION OF THE RECEIVER AND OPTOFIBRE

7. Repeat operations 2 and 3 above for the receiver, and direct it towards the light source.

8. Remove the window by loosening the six unmarked screws on the holder. Adjust the telescope so that the focal point is centred on the fibre holder. Use a piece of paper to find the spot from the light beam. Tighten all fixing screws.

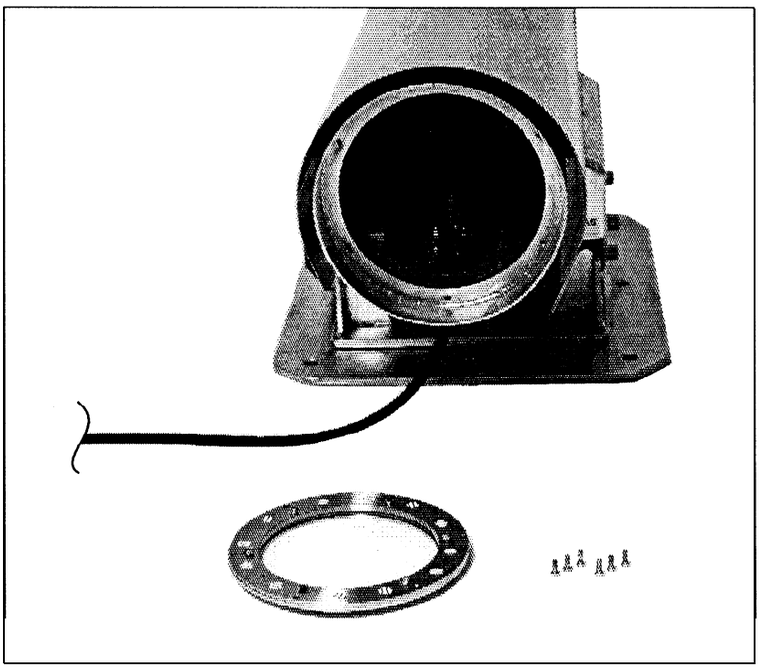

Figure 3.1 The window holder is mounted on the emitter and the receiver with the six outer, unmarked screws.

9. The position of the fibre holder can be adjusted by turning the three fine adjustment screws [31], [32] and [34]. To gain access to these, the protective screws must be removed. There are several holes on the underside of the telescope. The choice of hole depends on the position of the translator (see operation 11 below).

10. Start by adjusting the axial position of the holder. Move the holder vertically so that the light beam does not hit the holder. It is then possible to locate the focal point using a piece of paper, and then adjust on the focussing screw [32]. The focal point should lie in a plane in the middle of the pin for the holder.

11. If it was not possible to adjust the depth position using only the translator, then the whole mechanism must be moved relative to the telescope. The translator mechanism is held by four screws [29] and can be mounted in several different positions. Move the translator mechanism to a suitable position and remount it on the telescope. Readjust with screw [32].

12. Adjust the holder vertically and laterally so that the light spot is positioned in the middle of the hole of the fibre connection.

13. Put the optical fibre carefully through the hole in the base plate [33] and screw it into the fibre-optic cable connector [30]. Be careful not to damage the ends of the optical fibres. Position the fibre-optic cable in a smooth curve, and carefully tighten the grip nut so that the o-ring forms a seal against the cable.

14. The light transmission through the fibre should now be optimized. The use of an Opsis light meter LM 010 is recommended.

Small adjustments may be necessary from time to time. Factors which can affect the light intensity reaching the analyser are:

movement of the lamp holder and mirror in the emitter caused by heat generated by the lamp.

instability of the emitter mounting. Metal roofing will, for example, expand when heated by the sun in the summer. Vertical and horizontal movements are not, however, as critical as rotation.

instability of the receiver mounting. The angle of the receiver is critical.

Once the emitter and the receiver are installed, the distance between them has to be measured as accurately as possible. This distance should be entered in the **Installation** menu, see the analyser software manual.

- **Note that the accuracy of the distance directly affects the accuracy of the results.** A distance which is measured 10% too short will lead to results that are 10% too high.

To measure the distance, use a measuring tape, or, when the distance is longer, a detailed map over the area. The map should have a scale of 1:10 000, or better.

4. MAINTENANCE

4.1 CLEANING THE MIRRORS AND WINDOWS

The protective windows are made of quartz, and cleaning, therefore, causes no problems. Dirt and grease can be removed using a soft cotton cloth with acetone or pure alcohol. If the inside of the window requires cleaning, it should first be removed from the telescope, cleaned, and allowed to dry completely before being remounted. This will prevent unnecessary moisture and solvent vapour from getting into the telescope.

The mirrors are made of a thin layer of aluminium which is sputtered onto a quartz substrate. To protect the highly reflective aluminium surface from dirt and oxidation, ant to obtain a high reflectance in the short-UV wavelength region, a layer of magnesium fluoride, MgF_2, has been deposited on the mirrors in the ER 150.

The magnesium fluoride coating on the mirrors is very sensitive. It must not be touched or cleaned with liquids.

Magnesium fluoride is a salt which is soluble in most liquids, including water. Therefore, any dirt finding its way onto the mirrors must remain there. This will normally not pose a problem, as the mirrors are located far back in the telescopes. Loose dust may be removed gently with a dry, soft, cotton cloth or a photographer's lens brush.

The reflective surface is affected by the moisture which is present in the atmosphere. In time, the surface may become somewhat greyish, and this will affect the amount of light reaching the analyser. This process takes place more rapidly in the receiver than in the emitter as the mirror in the emitter is, to some extent, protected by the heat given off by the lamp. After a few years, it may, therefore, be necessary to replace one or both of the mirrors.

4.2 LAMP REPLACEMENT

The lamp and holder are shown in figure 1.3. The only tools required is a set of Allen keys.

Great care must be taken when mounting or removing the lamp. Before attempting to mount or remove a lamp, the following must be observed.

- Read through the safety regulations in section 2.1
- Ensure that the power supply is disconnected from the mains and then disconnect the lamp from the power supply.
- Use protective glasses. Cover naked skin on hands and arms.
- Do not remove the protective sheath from the lamp until absolutely necessary.
- Never touch the glass bulb.

Procedure for lamp replacement

1. Unscrew the window from the telescope, and loosen the cap for the ventilation. Unscrew the nut holding the lamp power cable [20]. Remove the lamp through the ventilation hole, after having loosened the two screws [23] holding it in place in the socket.

2. The new lamp is mounted in the same way as the old one. Start by transferring the protective sheath to the old lamp. Be careful to mount the new lamp with the anode, marked (+), upwards. Ensure that the lamp is pushed well down into the socket. Tighten screws [23] carefully. Do not over-tighten.

3. Reconnect the cable to the anode (positive terminal) on the top of the lamp. The nut [20] is then tightened well but carefully. If the cable connector shows signs of oxidation it should be cleaned before being reconnected.

4. Remount the window and the ventilation cap in the telescope.

If the lamp has been remounted correctly, the light intensity at the receiver will not have changed significantly. However, some fine horizontal and vertical adjustment, using the translator mechanism, may be necessary.

4.3 MIRROR REPLACEMENT

For replacing the mirror, the same tools as for the installation is required. When the mirror has been moved, the telescope must be realigned, and all adjustments of the beam have to be remade. When replacing the lamp mirror, a reflection screen, or similar, has to be used.

The mirror is attached to the telescope from the rear. The attachment is covered by a cap, which is pressed into the telescope. It can be removed by using a screw driver in the slot.

- **NOTE: The coating on the mirror is very sensitive. It must not be touched or cleaned with any liquids.**

The mirror holder is attached to the telescope by three screws ([5] in the figure below). To make it possible to adjust the angle of the mirror another three screws are threaded through the holder [4]. When starting the adjustments, these “pushing” screws [4] should be loosened entirely.

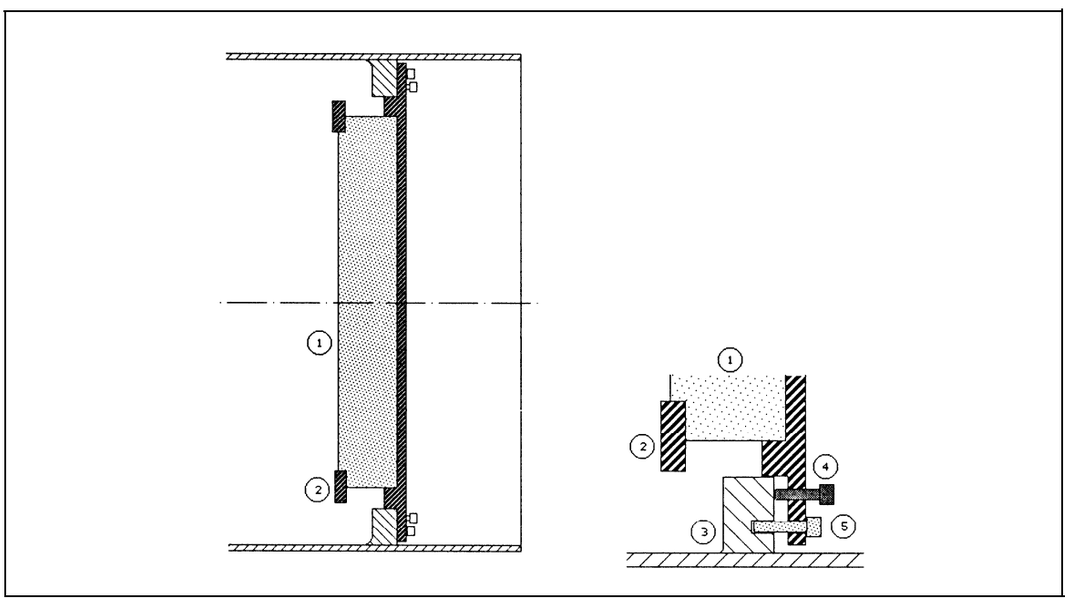

Figure 4.1 The rear of the telescope. The mirror attachment and the adjustment screw.

1 mirror
2 mirror holder
3 telescope attachment
4 adjustment screws (3 pcs)
5 attachment screws (3 pcs)

Procedure for mirror replacement

1 When the mirror in the emitter is to be replaced, turn off the lamp and allow it to cool down before starting the work.

2 Remove the rear cover with a screw driver. Loosen the three attachment screws [5], and pull the mirror out.

3 Loosen the clips which lock the mirror in position in the holder, and replace with a new mirror. Tighten the clips carefully!

4 Loosen the three adjustment screws [4] entirely, and attach the mirror unit to the telescope.

The mirror should now be adjusted so that the optical axis is parallel with the telescope axis.

Emitter adjustments:

5 Set the horizontal and the vertical adjustment translators for the lamp in their middle positions. Aim the telescope tube towards the reflection screen.

6 Use the adjustment screws [4] and the attachment screws [5] to move the beam, so that it is visible on the screen. Tighten all screws, and put back the rear cover.

7 Follow the instructions in the items 4 to 6 for the emitter installation, section **3.1.**

Receiver adjustments:

5 Set the horizontal and the vertical adjustment translators for the fibre holder in their middle positions.

6 Remove the optical fibre from the holder. Catch the light spot on a piece of paper and adjust its position with the mirror screws [4] and [5]. The spot should be as centered as possible in the connector. Tighten the screws and put back the rear cover.

7 Follow the instructions in items 9 to 13 in the receiver installation, section 3.1.

5. TROUBLE SHOOTING

Problem	Possible causes and action
The lamp does not function.	Check mains supply to power supply Check that power supply is properly earthed. Check that power cables are correctly connected and grip nuts tightened. Check that the power cable to the lamp anode is correctly connected and is not oxidized. Check that the lamp is properly earthed. Check the fuses in the power supply. See the manual for the PS 150 unit. The lamp may be burnt out. Replace with a new one. If the lamp still does not work, the power supply is probably faulty. Contact your Opsis representative.
There is no light reaching the receiver.	The lamp has gone. Bad visibility, preventing the light from reaching the receiver. The emitter is poorly aligned.
Light is reaching the receiver but the fibre is transmitting no signal.	The receiver is poorly adjusted. The optical fibre is broken. The optical fibre is badly connected.
Poor light is indicated for some substances being measured.	The lamp may be worn. The reflective layer on the mirror may be damaged.

6. ACCESSORIESFOR ER150

6.1 CALIBRATION CELL CC 150

The CC 150 cell is intended for field precision audit tests, and single point span calibrations where the monitoring path light source can be used. The cell has the following specifications:

cell length	about 5 cm (the exact length is engraved)
gas volume	approx. 500 cm^3
material	stainless steel, inside surface is electro-polished
windows	quartz, Herasil
gas connections	Swagelok, 6 mm

The cell should be mounted permanently in front of the receiver RE 150. The original window is then removed. When mounting the cell, do as follows:

- Locate the three screws holding the original window at the telescope front, see figure 3.1.
- Remove the window and attach the CC 150 cell. Use the six long screws enclosed with the cell.

The cell windows can be cleaned using a soft cloth and pure alcohole.

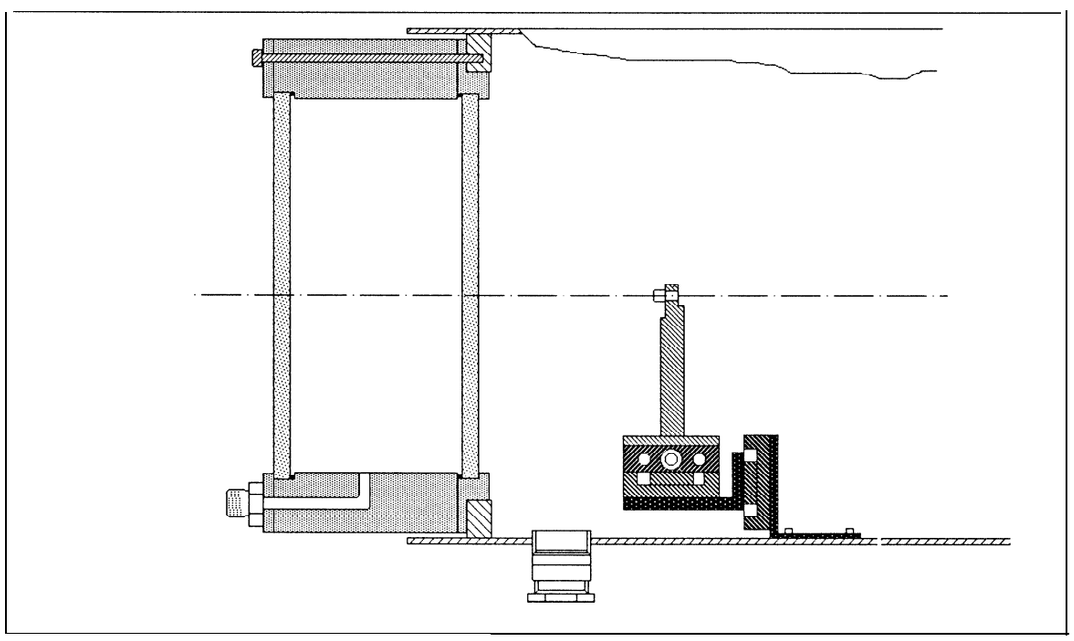

Fig. 6.1 The CC **150** cell is designed for permanent mounting on the receiver.